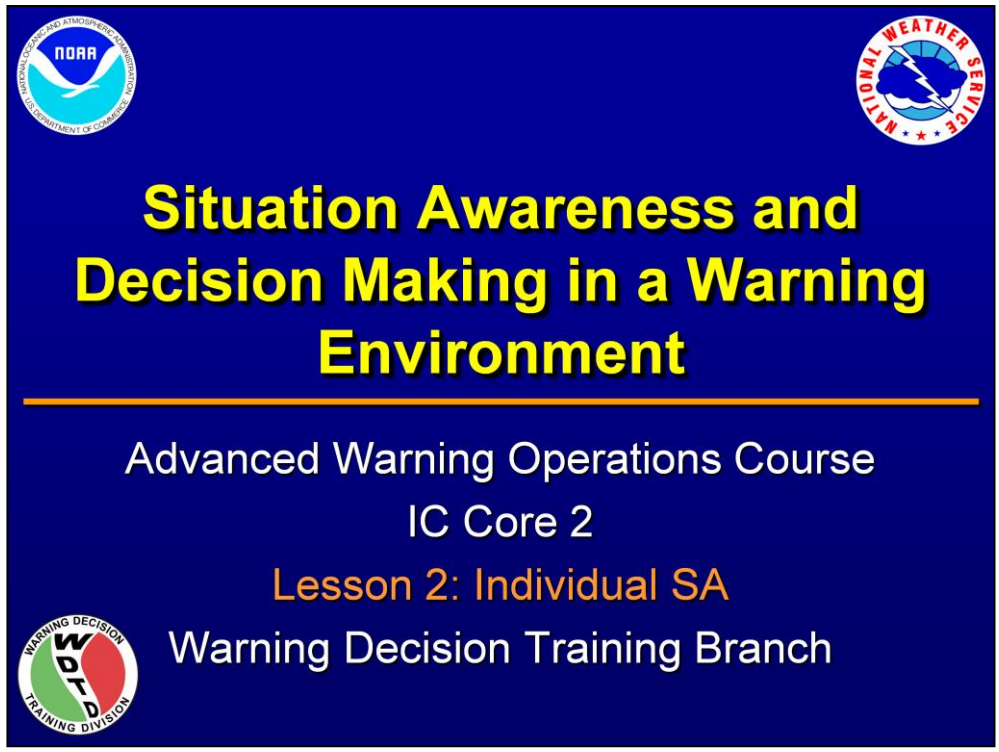
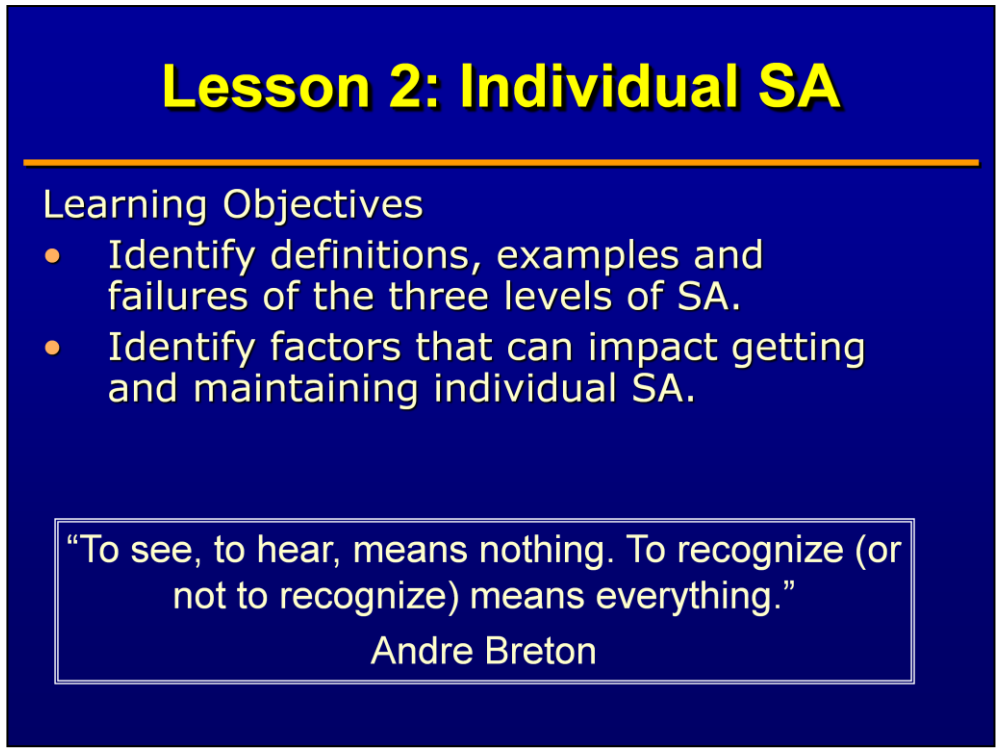
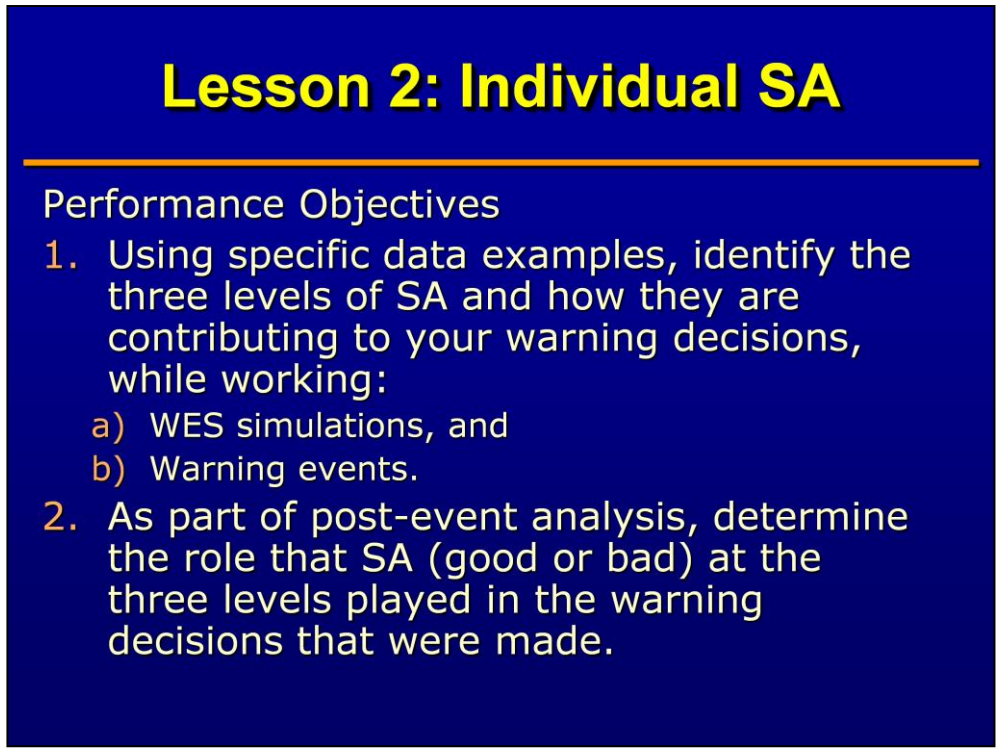


Lesson 2 will focus on the Situation Awareness (SA) of an individual. This lesson will take a look at the three different levels of SA, as well as examples of failures at each level.



The Learning Objectives for Lesson 2 apply to the definitions, examples, and failures of each of the three levels of SA. The objectives also address factors that can impact getting and maintaining SA. The Learning Objectives will be tested when you take the on-line exam for IC Core 2.



The Performance Objectives for Lesson 2 apply during this course as well as after completion. Though they are not tested formally, questions related to these Performance Objectives will be posed during the course simulations. Developing SA in the “domain” of the warning environment is a skill that evolves over time and is an important asset in making sound warning decisions.

Situation Awareness: The Ability to Maintain the Big Picture

Looks like one of the individuals is lacking SA in this domain…

SA supports your expectations. It also supports the process of shifting expectations during an event.

What SA is Not

"Howdy. My name is John. I am 40 years old and live in the USA.

I was born with brown hair, green eyes, and situation awareness."

SA is *not* an inherent ability. It is *acquired* for different domains, such as driving a car

SA is not something that you are born with. The ability to acquire SA is learned, and SA must be acquired for each domain. You already have SA in many domains in your life…for example, driving a car.

SA has been studied for many years in other domains. Here are examples of research papers from NASA, the FAA and others. There are many things in the NWS warning environment that are common to the military, aviation, emergency medicine, nuclear power, and other domains. All require decision making in high stress environments with significant uncertainty, time pressure and lives are often at stake.

Situation Awareness Definition

- ***Perception*** of the elements in the environment within a volume of space (Level 1)

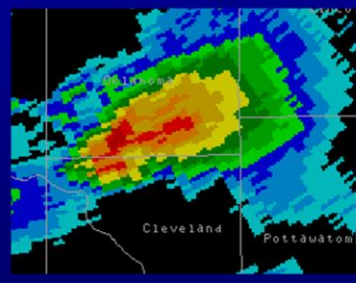
- ***Comprehension*** of their meaning (Level 2)
- ***Projection*** of their status in the near future (Level 3)

Endsley 1988

There are three levels of SA, as defined by Mica Endsley. Each level will be examined separately. Notice that none of these definitions involves making a decision! SA forms the ***framework*** for making decisions.

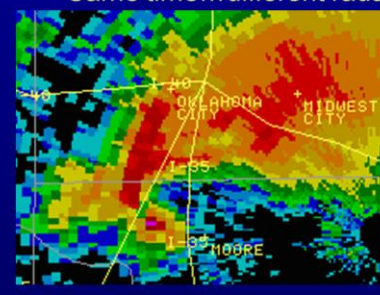
Situation Awareness Level 1

- ***Perception*** of the elements in the environment within a volume of space (Level 1)



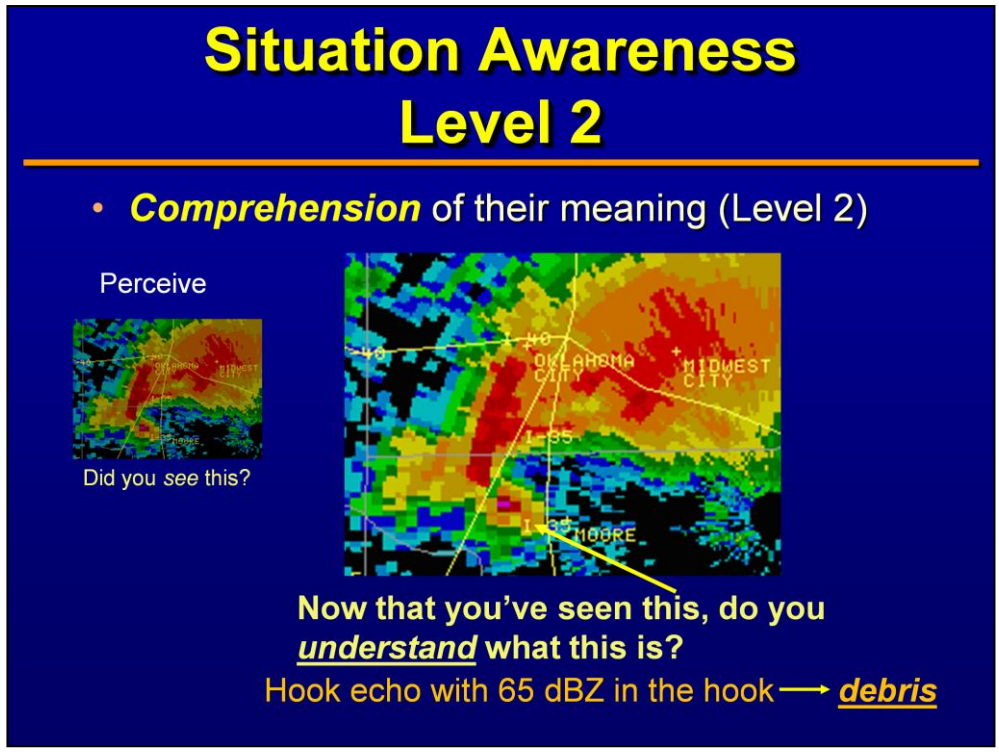
Is this what your decision is based on?

Same time…different radar



Or did you see this as well?

Level 1 SA involves simply seeing the relevant data in the domain. Since there is such an enormous volume of data available in the warning environment, success with level 1 SA requires looking at what is most appropriate. However, the most pertinent data may be unavailable, masked by system design or it may require a great deal of effort to find.

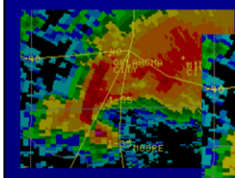


Level 2 SA involves your ability to comprehend the data and recognize patterns. In this example, you may understand the significance of a hook echo (and were able to see it in the data – level 1). The added significance of the high dBZ value in the tip of the hook is also (hopefully) comprehended. The radar beam is reflecting back from debris which has been lofted into the circulation.

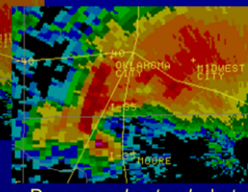
Situation Awareness Level 3

- ***Projection*** of their status in the near future (Level 3)

Perceive → Comprehend → **Project**



Did you *see* this?



Do you *understand* what this is?

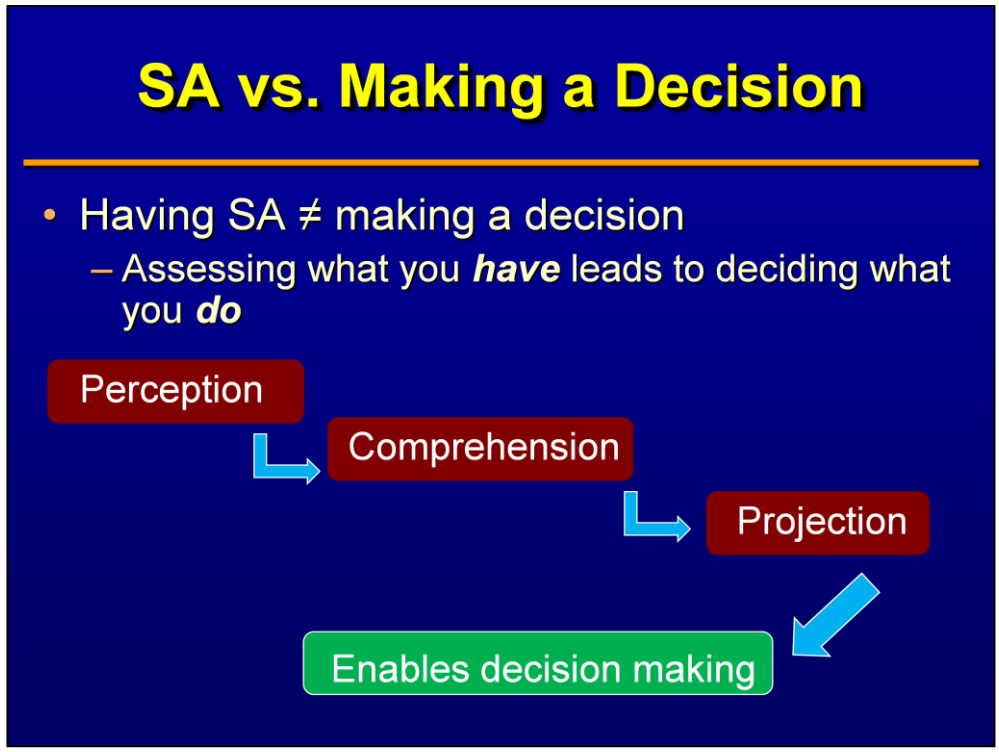
(Hook echo with 65 dBZ in the hook: debris)

Now do you realize what is likely to happen? And what you should do?

…Tornado Emergency for the OKC Metro……..

Level 3 SA involves mentally projecting this feature forward in time and understanding the associated consequences. With level 3 achieved, the decision on what to do next is usually straightforward.

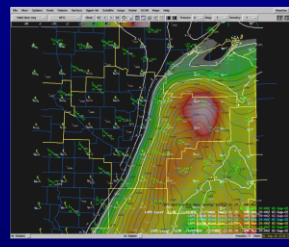
Note that attaining the three levels of SA is not the same as making a decision.

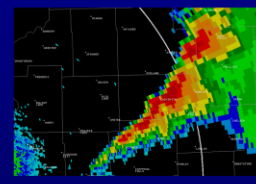


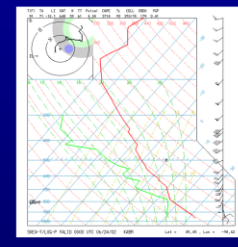
Though there are three levels of SA, none of these levels involves making a decision. Once all three levels of SA are achieved, the decision directly follows. SA provides the framework for making a decision.

Attaining and Maintaining Individual SA

- Attention
  - Switching among multiple data streams and managing task priority







  - Screen out the “noise” (audio and video)
  - Domain can be designed to support attention

SA can be enhanced if the domain is designed to support human attention, which is a limited resource. Our attention manages multiple data streams, as well as their relative priority. Attention must also function to screen out information that is not relevant. Irrelevant information is essentially noise, whether it is visual or audible. It is important that the domain (systems and people) does not overly tax human attention, and appropriate design can support attention.

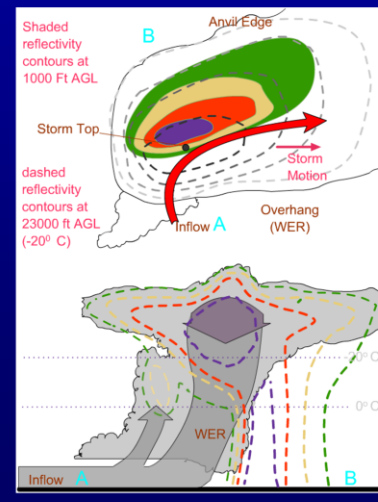
Attaining and Maintaining Individual SA

- Working memory (short term)
  - Processes and holds data in chunks
  - Supports a limited number of data chunks
  - Need enough data chunks for identifiable patterns

Another limited resource is working memory, where the data chunks found by our attention are stored. Working memory can support a limited number of these data chunks. We need enough of these data chunks to identify patterns in the data. Pattern recognition is critical for comprehension of the data. Hopefully, your working memory has enough chunks of relevant data to recognize relevant patterns!

Attaining and Maintaining Individual SA

- Long term memory
  - Conceptual models
  - Recognition of ***meaningful*** patterns
    - Conceptual models make the connections among the data chunks



You don't go around all the time thinking about HP supercells, but patterns associated with them reside in long term memory. This is where a number of conceptual models for severe weather would be stored. The conceptual model provides the necessary connections among the chunks of data in working memory. Accessing a conceptual model from long term memory during an event may not be conscious, but that feeling of "I've seen this before" means something!

Attaining and Maintaining Individual SA

- Attention and memory are limited resources
  - Significantly impacted by workload
- Automation can
  - Decrease workload for routine tasks
  - Increase workload for significant or unexpected events

- *Many aspects of workload are controllable*

Workload has a significant impact on SA, and it can be made manageable. Automation has increased so much in many domains. It can decrease workload for routine tasks, However, it can increase workload for significant or unexpected events. You'll be hearing a lot about unexpected events in the AWOC Core track modules. The good news is that many aspects of workload are controllable.

SA and Workload

	Low Situation Awareness	High Situation Awareness
High Workload	Don't know anything, but am trying way too hard to find out 	Do know plenty, but at great effort (can't keep this up for long!) 
Low Workload	Don't know anything, don't want to know… 	Do know, and it comes steadily *If you are not operating here, find out why and fix it!* 

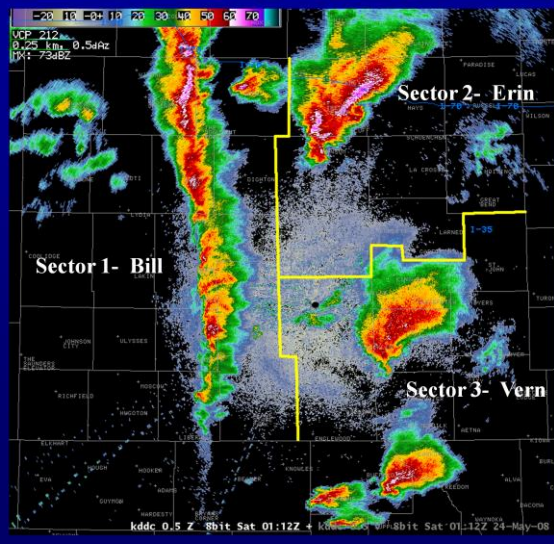
We'll start with low SA and high workload. This means you don't know what's going on and you're working too hard to find out. In aviation, this is known as "flying behind the plane". The next possibility is that you have high SA, but you are working too hard to maintain it. This is dangerous because it is not sustainable! How about low SA and low workload? You don't know what's going on and you aren't trying to find out. Maybe you're in "that doesn't happen here" mode? The goal is maintain high SA with a low workload . This doesn't mean that you are bored, but that the information flow is manageable. If you aren't operating in the high SA, low workload area, find out why and fix it! More about how to do that later.

SA and Workload

- Warning decisions require all three levels of SA
  - ***Perception*** of relevant data, ***Comprehension*** of patterns, and ***Projection*** to the near future
- Maintaining SA requires:
  - Proactive radar ***base data*** interrogation
  - Keeping number of storms for ***each*** forecaster ***manageable***
    - Sectorize (re-distribute workload)
    - Assure staffing is appropriate

Why is workload so important? Appropriate storm interrogation requires proactive analysis of the radar base data. Sectorizing can ensure that each warning forecaster has a ***manageable*** number of storms to interrogate.

Sectorizing and SA



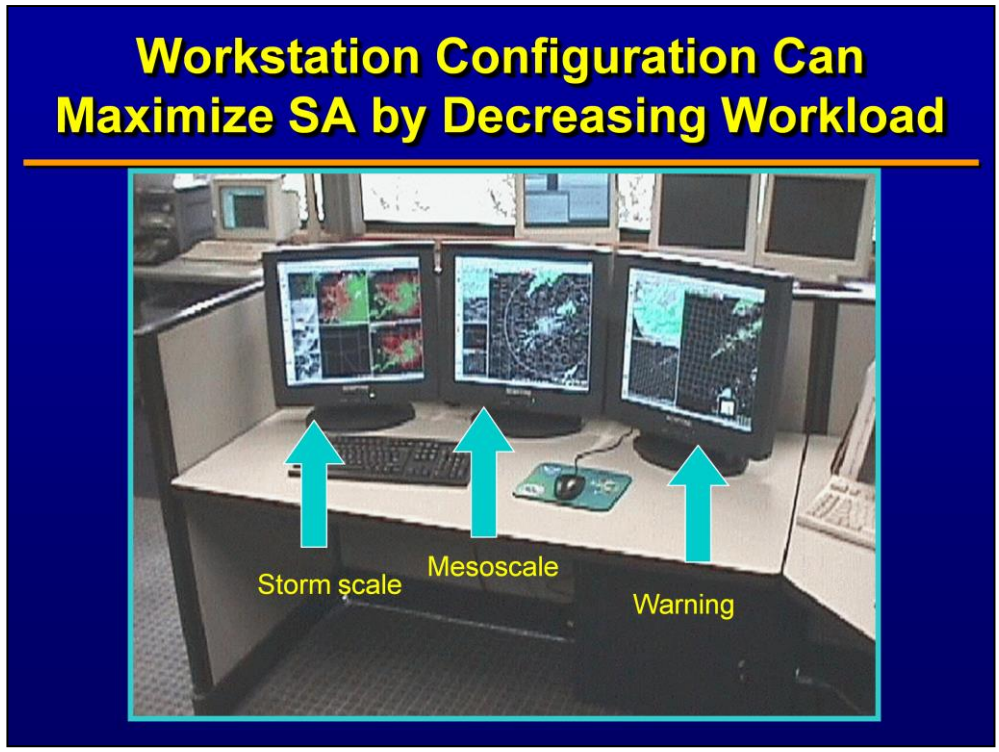
Advantages

- Divide the workload
- Focus on base data
- Maintain higher SA

Disadvantages

- Coordination becomes a challenge and must be managed

Sectorizing can have great benefits. In this example, there are three sectors, based on geography. The workload is divided such that each individual can maintain higher SA. The challenge with sectorizing is the need for an overall coordinator, providing oversight and “event level” SA. Storms may need to be passed from one sector to the next or sectors redefined. A designated warning coordinator can oversee this process and ensure that the event overall is managed.



Workstations can also be configured to support your SA. There are many possible configurations. In this example, two monitors are set up for storm scale and mesoscale analysis, respectively. The third monitor is set up to process warnings.

SA and Workload
One Final Comment

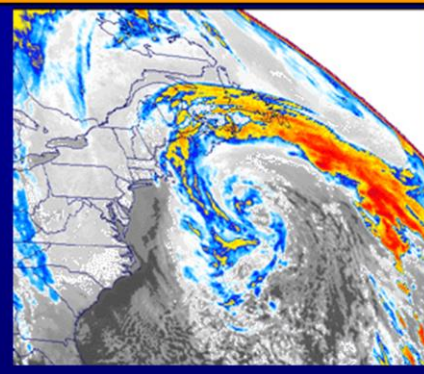
"Keep an extra person* available for the one thing that you did not plan to happen...ie…the media showing up at our building wanting to do interviews while warnings were being issued."

WDM IV Workshop Field Presentations

*that "extra person" is ***not*** the warning coordinator!

A recommendation from one of the WDM IV workshop field presenters! During a largely successful event, one thing that wasn't expected was a visit from the media. Having an extra person available for the unknowns can make a huge difference, and keeping that extra person available is the coordinator's decision. Though the warning coordinator may be able to do short interviews, his/her SA may be lost if too much time is spent away from maintaining the big picture.

Failures in Situation Awareness



"When you're in the denial business…it's hard to know when to stop."

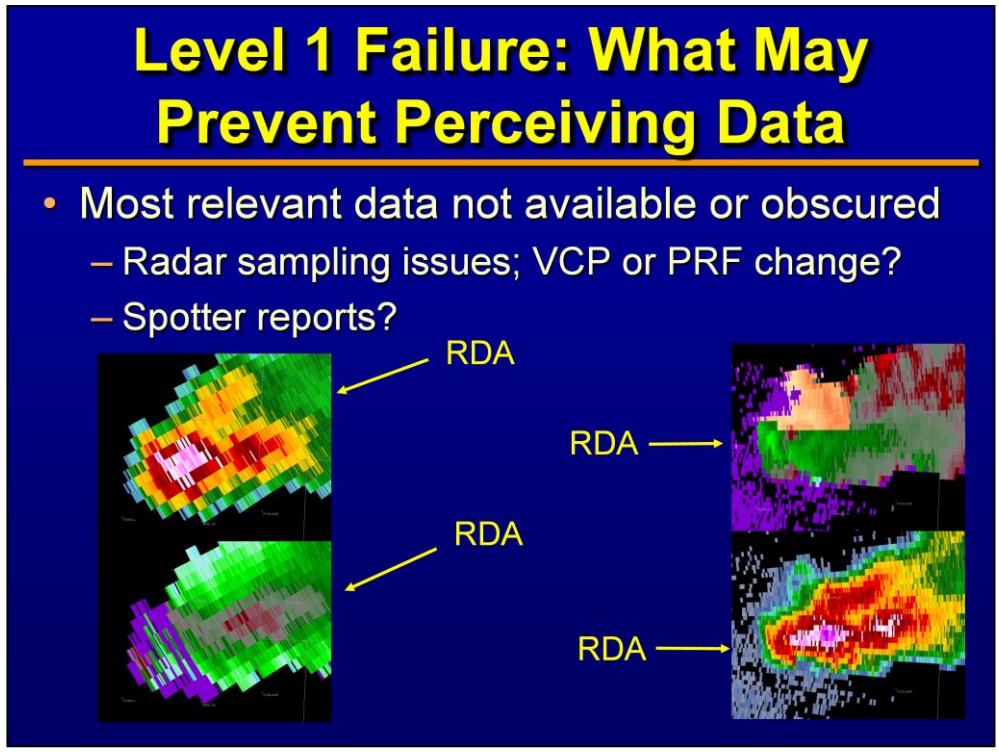
Sebastian Junger, The Perfect Storm

There are many different ways that each of the three levels of SA might fail. Denial is only one of the possibilities, but it was a factor in the loss of the Andrea Gail.

Level 1 Failure: What May Prevent Perceiving Data

- Most relevant data not available or obscured
  - Sometimes human intervention can correct this
- Data presented in too much detail
  - Must extract useful information from the glut
- User doesn't know what is relevant
- Distractions, workload

Level 1 SA is all about seeing the most relevant data. An important example for warning operations would be the masking of radar data by range folding. This problem can often be mitigated by changing the VCP, or editing the Doppler PRF, but workload may get in the way. Sometimes relevant data gets overlooked because it is embedded in too much irrelevant data. An example might be loading multiple AWIPS procedures that aren't really personalized for you. Inexperience may mean that you don't yet know what is the most relevant. Distractions and a high workload can negatively impact any of these contributors.



In this example, there is a storm viewed from two different radars, but there are data quality problems with the velocity products. From one viewing angle (left side of slide) part of the storm is embedded in range folding, while the other viewing angle (right side of slide) has a velocity dealiasing failure. These data uncertainties can cause a level 1 SA failure with respect to the radar data. Hopefully, alternatives exist, such as changing the VCP or the PRF, or having good spotter information.

Failure in Level 1 SA
NWS Example

- Negative lead time on storm with large hail
- Based on (not so good) expectations:
  - Only looking at lowest 4 elevations, instead of All Tilts
- Missed 100 kt storm top divergence

AWOC Core 3 RCA

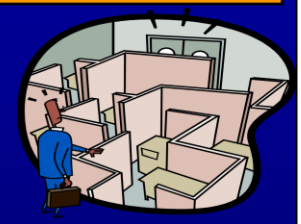
Here's an NWS example of a level 1 failure, drawn from a Root Cause Analysis exercise, which you will get to do as part of Core 3. This event was a missed hail event. The most relevant data was at the mid and high levels, but it was missed because they were only looking at the lowest four elevations. This "failure to seek" was based on a poor mental model, which drove expectations, which drove the data choices. More about the impacts of poor mental models later….

Failure in Level 1 SA
NWS Example

- ***Contributors*** to an unwarned tornado
  - Feature masked by range folding
    - PRF not changed
    - Different VCP?
  - Storm at long range
    - Sampling limitations not well understood?
    - Data from other radars available?
  - Workload overwhelming
    - Sectorizing? Need additional staff?

Other NWS examples presented in IC Core 2 are drawn from service assessments or presentations from field representatives at WDTB workshops. In this case, a tornado developed from a storm that was in an area of range folding. Perhaps the staff was unfamiliar with the procedure to change the PRF, weren't sure about an alternate VCP or just didn't have time to do either. Since the storm was at long range, perhaps looking at an adjacent radar would have been helpful. The workload was overwhelming, likely contributing a great deal to the lost perception of the significance of this storm. Additional staff and/or sectorization may have mitigated the workload impact.

Level 2 Failure: What May Prevent Comprehending Data

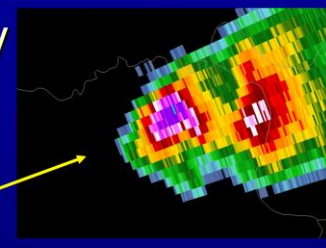


- Inability to connect data chunks to a known conceptual model
  - Multiple data streams often needed
- Lack of a relevant conceptual model
- Lack of experience
- Distractions, workload

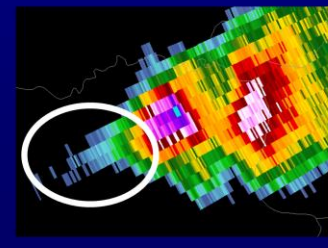
In the warning environment, level 2 SA requires comprehension of multiple data streams (radar images, spotter reports, near storm environment data) to support the pattern recognition and build the connection to the conceptual model. If the relevant data are seen but not understood, level 2 SA with respect to a conceptual model may be lost. Lack of experience can limit comprehension, even if the data are readily available. Distractions and a workload that is too high can also compromise level 2 SA.

Level 2 Failure: What May Prevent Comprehending Data

- Storm from radar A with very high dBZs: hail suspected as a threat



- Storm from radar B: Do you know what the appendage ***means***?



3 body scatter spike, which implies ***very large*** hail

In this example, the view from radar A depicts a storm with very high dBZs in its core, which would make hail a suspected threat. However, the view of the same storm from an adjacent radar reveals a 3 body scatter spike. If you understand what that means, your level 2 SA on this storm now includes the likelihood of very large hail. The 3 body scatter spike adds significant additional information, if you understand what it means.

Failure in Level 2 SA
NWS Example

- Unwarned flash flood
- Conceptual model of flash flood "not used"
  - Threat assumed to be minimal
- Distracted by overwhelming severe weather workload
- Lack of experience

AWOC Core 3 RCA

In this NWS example from an AWOC RCA, the conceptual model of a flash flood was "not used". Since the threat was thought to be minimal, the data chunks were not being put together. The other contributors were an overwhelming workload and a lack of experience.

Failure in Level 2 SA
NWS Example

- ***Contributors*** to an unwarned tornado
  - Conceptual model of tornadic supercell not well understood
  - Report of previous tornado with storm not relayed to warning forecaster
  - 3D storm analysis incomplete
    - Inadequate RPS lists

In this event, a storm had previously produced a tornado, but a delayed report of the tornado was not relayed to the warning forecaster in real time. Additionally, the ability of the warning forecaster to interrogate the storm was compromised by inadequate RPS lists. The conceptual model of this tornadic supercell might have been better understood if the tornado report was passed on and the storm had been more thoroughly interrrogated.

Level 3 Failure: What May Prevent Correctly Projecting Data

- Limited understanding of conceptual model
- Inability to deal with conflicting storm expectations due to data limitations
  - Radar sampling
  - Near storm environment analysis

- Limited experience
  - Knowledge of local area
  - Population centers, outdoor events
- Distractions, workload

Level 3 SA requires a thorough understanding of conceptual models, sufficient to predict future threats. So lack of experience or lack of a relevant conceptual model (or both) greatly impact level 3 SA. The data streams used in warning decisions all have strengths and limitations, which must be understood. A storm's expected future behavior may be incorrect or inconclusive due to data limitations. The combination of limitations from radar and near storm environment may result in projections that are in conflict or in error.

The storm's impact must also be projected, such as passing through populated areas or crowded outdoor events.

Level 3 Failure: What May Prevent Correctly Projecting Data

- Conceptual models must be familiar enough to
  - Be understood from the data (Level 2 SA)
  - Know what to expect in the near future (Level 3 SA)
- Example: Storm has produced a tornado but now
  - Max reflectivity decreases and top has lowered
  - Circulation has weakened
  - Near storm environment not significantly different
- How does this behavior fit with the conceptual model of a tornadic supercell?

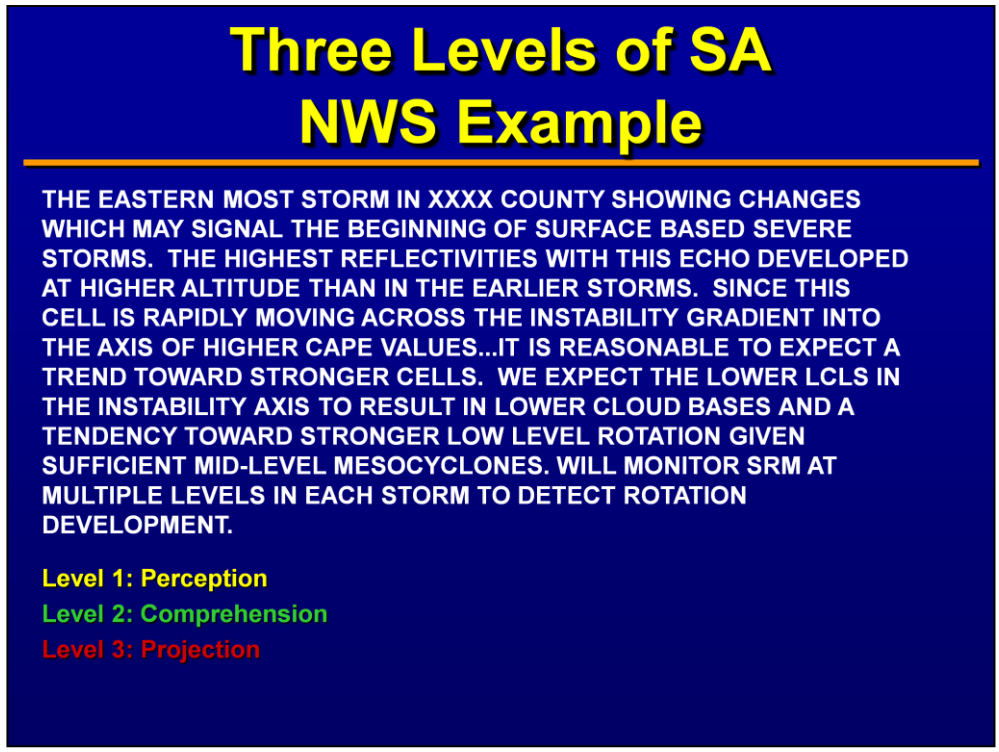
In this example, a storm has previously produced a tornado. Now the radar data shows a lowering top, lower max reflectivity and a weakening circulation. The near storm environment is not significantly different, so the question to ask is how does this behavior fit the model of a tornadic supercell?

Failure in Level 3 SA
NWS Example

- Supercell has previously produced a tornado, but radar features less significant
  - Conclusion: storm is weakening
  - Decision: warning allowed to expire
  - Result: new warning issued with no lead time when tornado redevelops

- Cyclic nature of tornadic supercells not well understood?
  - Near storm environment: has storm moved to an area where weakening makes sense?

In this example, the radar features were assumed to mean that the storm was weakening and the warning was allowed to expire. The cyclic nature of tornadic supercells was not sufficiently understood, thus not projected. This level 3 failure resulted in a reactive tornado warning with little lead time.



As an exercise, take a look at this excerpt from a regional weather discussion. Identify the different levels of SA represented in the phrases. Statements of perceived data represent level 1. Statements of the meaning of the data represent level 2, and statements projecting the consequences of that meaning represent level 3.

Three Levels of SA
NWS Example

THE EASTERN MOST STORM IN XXXX COUNTY SHOWING CHANGES WHICH MAY SIGNAL THE BEGINNING OF SURFACE BASED SEVERE STORMS. THE HIGHEST REFLECTIVITIES WITH THIS ECHO DEVELOPED AT HIGHER ALTITUDE THAN IN THE EARLIER STORMS. SINCE THIS CELL IS RAPIDLY MOVING ACROSS THE INSTABILITY GRADIENT INTO THE AXIS OF HIGHER CAPE VALUES...IT IS REASONABLE TO EXPECT A TREND TOWARD STRONGER CELLS. WE EXPECT THE LOWER LCLS IN THE INSTABILITY AXIS TO RESULT IN LOWER CLOUD BASES AND A TENDENCY TOWARD STRONGER LOW LEVEL ROTATION GIVEN SUFFICIENT MID-LEVEL MESOCYCLONES. WILL MONITOR SRM AT MULTIPLE LEVELS IN EACH STORM TO DETECT ROTATION DEVELOPMENT.

Level 1: Perception

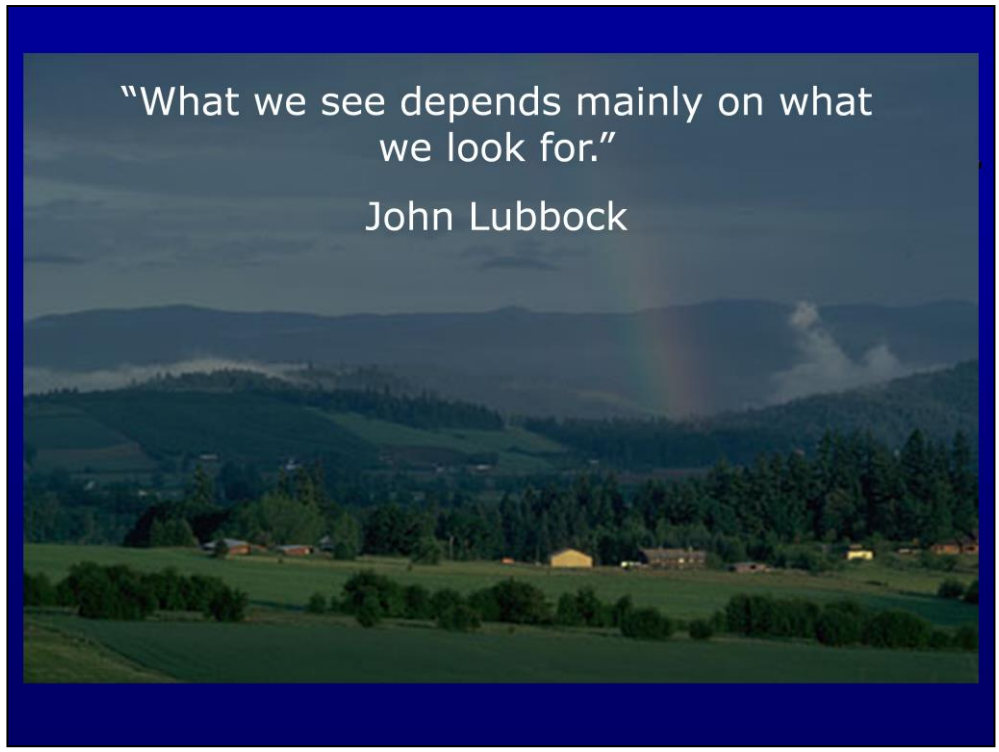
Level 2: Comprehension

Level 3: Projection

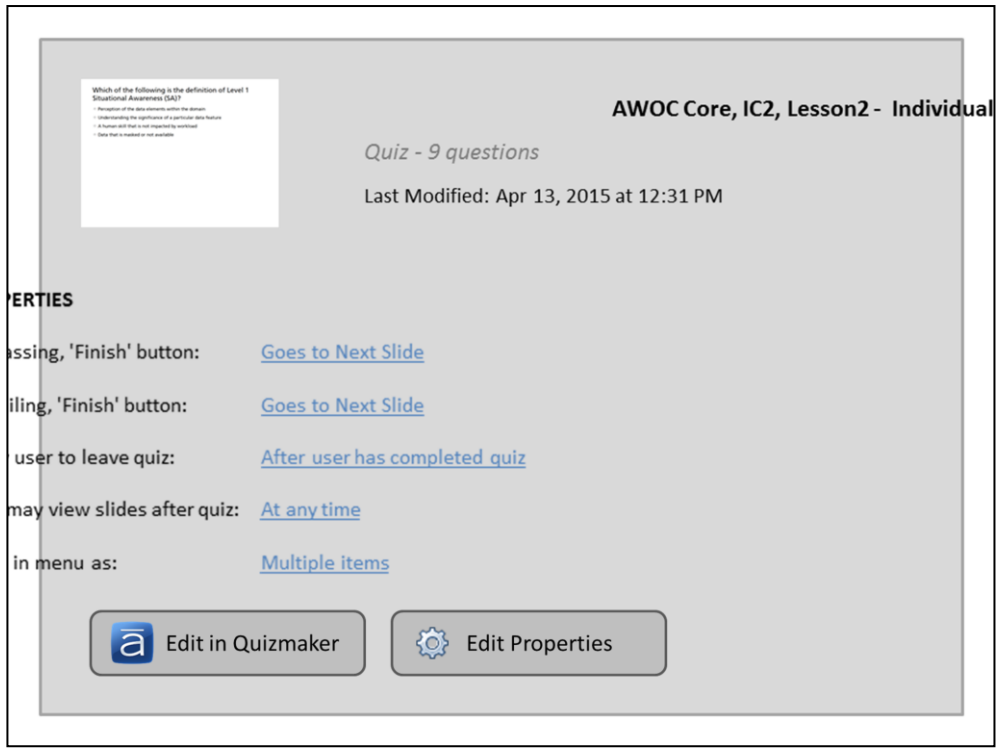
SA Summary

- SA is the ability to step out, construct and maintain the big picture
- Controllable factors aid your ability to have it and keep it
- Understanding how these factors come together affects your ability to manage SA better in the future

In summary, SA is the ability to build and maintain the big picture, which supports your ability to make sound warning decisions. There are several controllable factors, such as workload, which can support your ability to have good SA. Developing the ability to have good SA in the warning environment in the future is dependent on understanding how these controllable factors come together.



John Lubbock reminds us that what we perceive is often limited to what we are looking for.


Which of the following is the definition of Level 1 Situational Awareness (SA)?
AWOC Core, IC2, Lesson2 - Individual
Quiz - 9 questions
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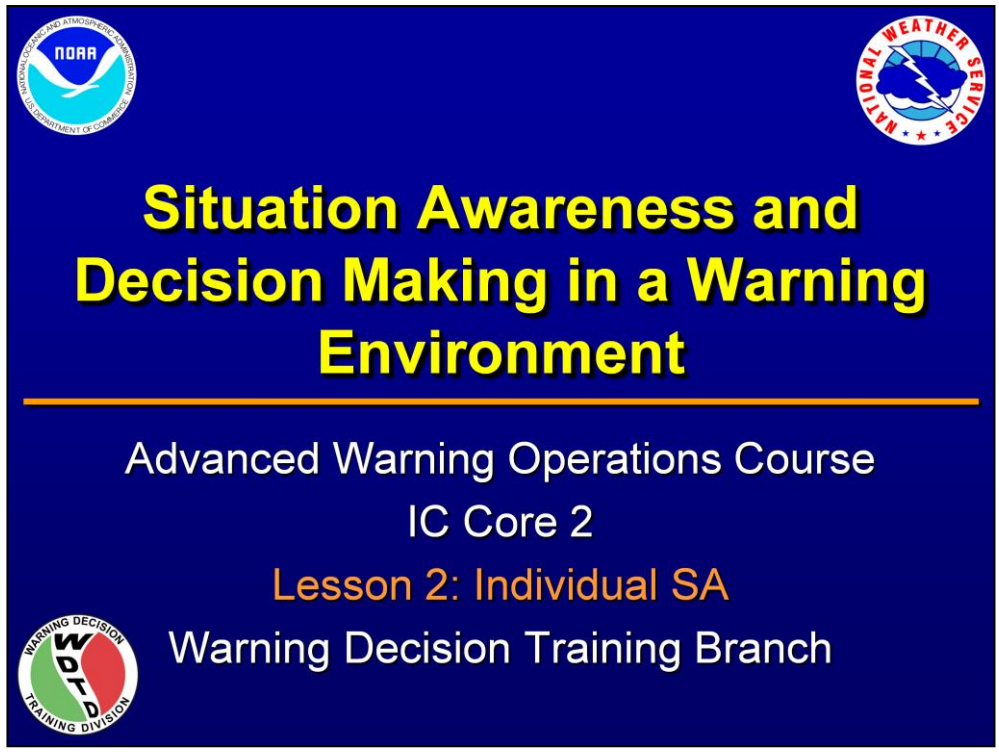
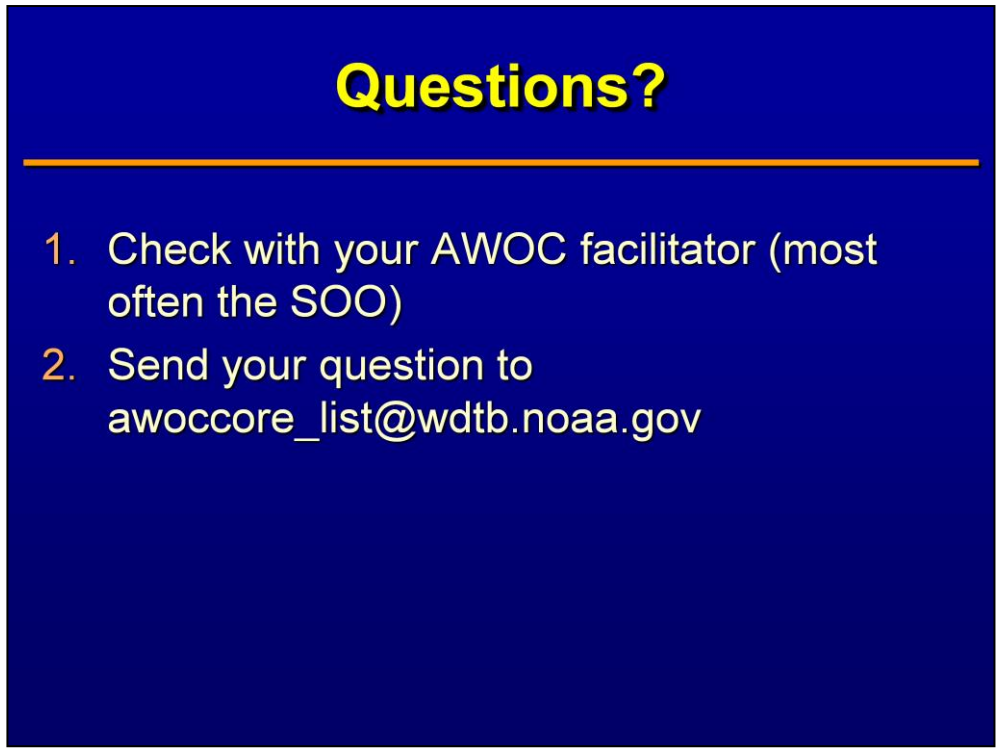


This concludes Lesson 2: Individual SA. There are three remaining lessons for IC Core 2.



If you have questions about the material from IC Core 2, first check with your AWOC facilitator (most likely your SOO). If your AWOC facilitator cannot answer your question, please send an email to awoccore_list@wdtb.noaa.gov.